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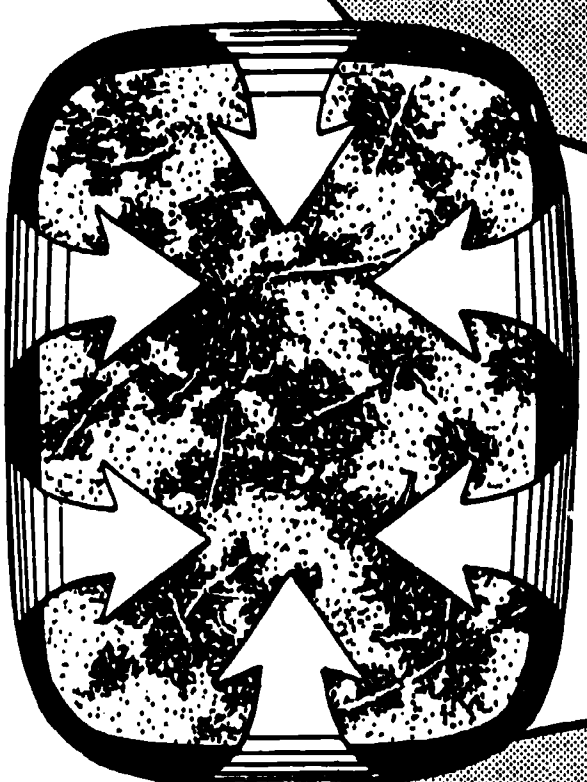
ABSTRACT

This instructor's guide contains materials needed for teaching a two-lesson unit on oxidation ditches. These materials include: (1) an overview of the two lessons; (2) lesson plans; (3) lecture outlines; (4) student worksheet (with answers); and (5) two copies of a final quiz (with and without answers). The first lesson: reviews the theory, structure, and components of the oxidation ditch system; discusses nitrification/denitrification and its importance to oxidation ditch operation; and outlines and explains process monitoring and process control techniques. (This lesson is designed to be presented with the aid of a set of 35mm slides accompanying the unit. The second lesson, which is more advanced, covers the topics of carbonaceous and nitrogenous oxidation and their importance in oxidation ditch process control. Since this lesson could be considered optional for instruction at the intermediate level, the student worksheet and final quiz cover only the material presented in the first lesson. (JN)

Biological Treatment Process Control

Oxidation Ditches



Instructor's Guide

Linn-Benton Community College
Albany, Oregon 1984

BIOLOGICAL TREATMENT PROCESS CONTROL

OXIDATION DITCHES

INSTRUCTOR'S GUIDE

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OXIDATION DITCHES

Instructor's Guide

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OXIDATION DITCHES

Overview of Lessons

This unit on Oxidation Ditches is divided into two lessons. Lesson I reviews the theory, structure, and components of the oxidation ditch system. Nitrification/Denitrification is discussed and its importance to oxidation ditch operation explained. Process monitoring and process control techniques are outlined and discussed. Lesson I is designed to be presented with the aid of the 35 mm slides accompanying this unit.

Lesson II does not have slide support. This lesson, which is more advanced, covers the topics of carbonaceous and nitrogenous oxidation and their importance on oxidation ditch process control. This lesson could be considered optional for instruction at the intermediate level. Therefore, the worksheet and final quiz cover only the material presented in Lesson I.

Lesson Plans

Lesson I - Introduction, Theory & Components

- Have students read text material ahead of time, if possible.
- Lecture from outline with slide support (about 45 min).
- Assign worksheet (10 - 15 min).
- Correct and discuss worksheet (15 - 20 min).
- Assign final quiz (15 min).

Lesson II - Process Kinetics and Process Control (Optional)

- Assign text material
- Lecture using overhead or chalk board presentation depending on instructor preference.
- Conduct open discussion
- Design and assign worksheet to match needs and level of specific student group.

Additional Comments:

- A visit to an operating oxidation ditch plant would be desirable. If a visit is possible, have students measure dissolved oxygen around the ditch to emphasize the concept of aerated and anoxic zones.

- For classroom demonstrating provide fresh activated sludge from an oxidation ditch for the students to perform settling rate tests and to observe microorganisms under the microscope.

- Collect samples of raw, primary effluent, and final effluent in jars to compare characteristics.

- Have samples of trend charts for plotting of process control indicators.

OXIDATION DITCHES

LECTURE OUTLINE

Lesson I - Introduction, Theory & Components

Slide #3

History of the Oxidation Ditch Process

Names: Pasveer Oxidation Ditch Process

Loop Aeration

Carrousel Process

Orbital System

Developed in the Netherlands by I.A. Pasveer

First System in 1954

In 1975 there were 558 Oxidation Ditch Plants in the U.S.

Slide #4

Principles of the Oxidation Ditch

Application of the Extended Aeration, Complete Mix Concept of Activated Sludge

A Closed-loop Trench Aeration Tank

Lost Cost Construction - Advantage

Disadvantages due to Aeration Effectiveness, Detention Time, Flow Pattern when Scaled Up Significantly

Slide #5

Multiple-Trench Systems

Multiple Small Units

Carrousel System

Several Circular Tanks One Inside the Other; The Inner Most Tank is the Clarifier, the Outer Tanks the Aeration Basins.

Partitions Channel the Flow

Designs of 5-20 MGD Applicable

Slide #6

Advantages - Estimated to be Cheapest System to Build in the 0.1-4.0 MGD Range

Carrousel Design Make Almost Any Size System Competitive

-Relatively Low Operation Costs

-Tolerates Shock Loads Because of High MLSS and Long Detention Time

-Requires Minimal Operational Guidance

-Nitrification/Denitrification can be Accomplished in Sar Basin

Disadvantages - Space Requirement Relatively Large because of Extended Aeration Mode

-Control of Aeration Difficult

The Oxidation Ditch System Components--

Slide #7

The Oxidation Ditch

Trenches Dug into Earth

Free Standing Concrete Basins

Oval or Circular

Slide #8

The Aeration Devices

Rotating Brushes Across the Channel

Whip Oxygen into the Water and Propel the Water Around the Basin

Slide #9

Brush Type - Horizontal Shaft 70-80 rpm

Disc Type - Large, Vaned Discs on Horizontal Shaft, Partially Submerged; 30 rpm

Clarifier

Separation of Solids

Separate Basins & Settling in Aeration Basins

Wasting & Return Sl e Capabilities

Solids Handling

The Aeration Process--

Slide #10

Aeration: 1-3 mg/l D.O.

Anoxic Zone (0 m/l D.O.)

Nitrification/Denitrification

Slide #11

Horizontal Movement

At Least 1 ft/sec

Baffle

Slide #12

Suspended Growth

Organisms and food Mixed and Moving Together

Loading and Operating Conditions--

Slide #13	Detention Time
	SRT 15-30 Days
	Aeration Time 24 Hours
Slide #14	Solids Concentration in Basin
	MLSS 4000-6000 mg/l
Slide #15	Loading Condition
	F/M = 0.25-0.35

<u>Lesson II - Process Control and Process Kinetics</u>

Slide #16	Process Control
	Evaluating Sludge Settleability
	Settleometer
	SVI
Slide #17	Solids Inventory
	DOB
	Solids in Clarifiers
	MLSS
	Wasted Solids
Slide #18	Return Sludge Rate
	RAS 40-45% of Influent Flow
	Used to Balance Sludge Inventory
	Segmented Wasting Schedule
	Waste Sludge Rate (WAS)
	Methods to Follow Process Should be Trend Charted
	FM
	SRT
Slide #19	Dissolved Oxygen Control
	Oxygen Profile
	Base Operation on System Response
	Process Should Dictate Guidelines

Process Kinetics

- Oxidation of Organic Carbon Compounds
- Oxidation of Organic Nitrogen Compounds
    - Sources of Nitrogen ($NH_4 \pm N$)
        - Urine 0.5-3 g/day/adult
        - Feces 1-2 g/day/adult
    - Concerns with Nitrogen
        - Algae Blooms
        - Toxic Effects
        - Interference with Disinfection
        - Impact on pH
        - D.O. Demand
            - 4.75 mg O_2/mg $NH_4 \pm N$

Slide #20 — Nitrification/Denitrification

Slide #21 — Balancing Oxidation and Reduction

- Promote Nitrification and Allow Carbonaceous Oxidation to Follow
- Nitrification
    - D.O. Residual of 1-3 mg/l
    - SRT 15-30 day
    - MLSS 4000-6000 mg/l
    - pH 6.5-8.0
        - 10:1 alk/NH_4^+
    - Temp
- Denitrification
    - Facultative Organism Shift Quickly
    - Anoxic vs anaerobic
    - Alternating
        - Anoxic/Aerobic Zones

Daily Operational Activities--

Slide #22, #23, #24	Loading and Operating Ranges Required
	D.O. 1-3 mg/l
Slide #25, 26	MLSS 4000-6000 mg/l
	SRT 15-30 days
	F/M 0.25-0.35
Slide #27	Housekeeping
Slide #28	Equipment Maintenance
	Pumps and Motors
	Clarifiers
	Aerators
	Lab
Slide #29	Safety
Slides #30-34	Review

OXIDATION DITCHES

Name ______________________

Answers to Worksheet Problems

1. Calculate the volume of an oxidation ditch which has a cross-section as shown below and is 350 feet around in the center of the basin.

$$V = \text{Area} \times \text{Length}$$

$$= 1/2(L_1 + L_2) \times H \times \text{Length}$$

$$= 1/2(20 + 16) \times 5 \times 350$$

$$= 31{,}500\ \cancel{ft^3} \times \frac{7.48\ \text{gal}}{\cancel{ft^3}}$$

$$= 235{,}620\ \text{gal or } 0.236\ \text{Mgal}$$

2. Calculate the aeration time for an oxidation ditch which has a volume of 0.33 Mgal and an influent flow of 260 gpm.

$$\text{D.T.} = \frac{\text{Vol}}{\text{Flow}}$$

$$= \frac{0.33\ \cancel{\text{Mgal}} \times 1{,}000{,}000\ \cancel{\text{gal}}}{260\ \frac{\cancel{\text{gal}}}{\cancel{\text{min}}} \times \frac{60\ \cancel{\text{min}}}{\text{hr}} \times \cancel{\text{Mgal}}}$$

$$= 21\ \text{hrs}$$

3. If a float in an oxidation ditch travels 50 ft in 38 sec, what is the horizontal velocity in feet per second?

$$\text{Vel} = \frac{\text{distance}}{\text{time}}$$

$$= \frac{50\ \text{ft}}{38\ \text{sec}}$$

$$= 1.32\ \text{ft/sec}$$

4. Calculate the F/M ratio for an oxidation ditch which has a volume of 1.0 Mgal with MLSS of 5000 mg/l loaded with a flow of 10 MGD and a BOD of 170 mg/l.

$$F/M = \frac{\text{lbs BOD per day}}{\text{lbs MLSS}}$$

$$= \frac{170 \text{ mg/l} \times 10 \text{ MGD} \times 8.34}{5000 \text{ mg/l} \times 1.0 \text{ Mgal} \times 8.34}$$

$$= 0.34$$

5. If the influent flow is 3 MGD and the RAS flow is 875 gpm what is the percent return flow?

$$\text{Percent return} = \frac{\text{Influent Q}}{\text{RAS Q}} \times 100\%$$

$$= \frac{\dfrac{875 \cancel{\text{gal}}}{\cancel{\text{min}}} \times \dfrac{1440 \cancel{\text{min}}}{\cancel{\text{day}}} \times \dfrac{\cancel{\text{Mgal}}}{1000000 \cancel{\text{gal}}}}{3 \dfrac{\cancel{\text{Mgal}}}{\cancel{\text{day}}}} \times 100\%$$

$$= 42\%$$

OXIDATION DITCHES

Name ______________________

Final Quiz

Multiple Choice: Choose the best answer(s) and place an "X" in front of the corresponding letter.

1. Which of the following is not a term commonly used to identify an oxidation ditch?

____ a. Pasveer Oxidation Ditch
____ b. Loop Aeration
____ c. Loop Lagoon
____ d. Carrousel Process
____ e. Orbital System

2. The oxidation ditch process was developed in

____ a. England
____ b. United States
____ c. Holland
____ d. Germany
____ e. Denmark

3. The oxidation ditch process is a modification of

____ a. the trickling filter
____ b. extended aeration activated sludge
____ c. RBC's
____ d. ABF
____ e. aerated lagoon

4. The carrousel variation is most applicable to the ________ flow range.

____ a. 0.5-1 mgd
____ b. 0-5 mgd
____ c. 5-20 mgd
____ d. 20-50 mgd
____ e. 50-100 mgd

5. The oxidation ditch is designed to operate at _______ mg/l D.O.

____ a. 0.1-0.5 mg/l
____ b. 1-1.5 mg/l
____ c. 0-2 mg/l
____ d. 1-3 mg/l
____ e. 5-10 mg/l

6. Horizontal velocity of activated sludge around the ditch should be

____ a. 0.5 ft/sec
____ b. 1.0 ft/sec
____ c. 2.0 ft/sec
____ d. 5.0 ft/sec
____ e. 10.0 ft/sec

7. MLSS concentration in the aeration ditch should be

____ a. 500-1000 mg/l
____ b. 1000-1500 mg/l
____ c. 2000-4000 mg/l
____ d. 4000-6000 mg/l
____ e. 8000-10,000 mg/l

8. F/M ratios for aeration ditch loading are in the ________ range.

____ a. 0.01-0.2
____ b. 0.1-0.25
____ c. 0.25-0.35
____ d. 0.3-0.5
____ e. 0.5-1.0

9. Which <u>two</u> tests are used to evaluate sludge settleability?

____ a. volatile solids
____ b. MLSS
____ c. settleometer
____ d. centrifuge
____ e. SVI

10. Wasting sludge from the system will have a long term effect on (choose 3 answers):

____ a. DOB
____ b. MLSS
____ c. sludge age
____ d. BOD
____ e. solids inventory

11. Algae blooms, D.O. demand, disinfection interference, impact on pH and toxic conditions can all be a result of

____ a. excess nitrogen
____ b. excess organic carbon
____ c. excess D.O.
____ d. inadequate oxidation
____ e. stratification

12. The condition in which oxygen is relatively low is called

____ a. anaerobic
____ b. anoxic
____ c. aerobic
____ d. nitrification
____ e. stabilization

13. Which of the following conditions favor nitrification? (choose 3 answers)

____ a. D.O. 1-3 mg/l
____ b. anoxic
____ c. pH 6.5-8.0
____ d. MLSS 4000-6000 mg/l
____ e. low ammonia concentrations

14. Daily operational activities should include (choose 4 answers):

____ a. housekeeping
____ b. safety consciousness
____ c. equipment inspection
____ d. laboratory testing
____ e. sludge hauling

15. Operational control of an oxidation ditch process should be based on (choose the <u>best</u> answer):

____ a. DOB & settleometer
____ b. centrifuge & MLSS
____ c. F/M ratio coupled with a consideration of sludge age
____ d. how the system responds to parameters tracked over a period of time by trend charts
____ e. the phases of the moon

Name ______________________________

Answers for Final Quiz

Multiple Choice: Choose the best answer(s) and place an "X" in front of the corresponding letter.

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X a. excess nitrogen
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X b. anoxic
___ c. aerobic
___ d. nitrification
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13. Which of the following conditions favor nitrification? (choose 3 answers)

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X c. pH 6.5-8.0
X d. MLSS 4000-6000 mg/l
___ e. low ammonia concentrations

14. Daily operational activities should include (choose 4 answers):

X a. housekeeping
X b. safety consciousness
X c. equipment inspection
X d. laboratory testing
___ e. sludge hauling

15. Operational control of an oxidation ditch process should be based on (choose the <u>best</u> answer):

___ a. DOB & settleometer
___ b. centrifuge & MLSS
___ c. F/M ratio coupled with a consideration of sludge age
X d. how the system responds to parameters tracked over a period of time by trend charts
___ e. the phases of the moon